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EXTRUSION OF BIMETALLIC ADAPTERS MADE FROM STAINLESS STEEL WITH--ETC(U)
FEB 79 L A NIKOL'SKIY, V M KIRASIROV
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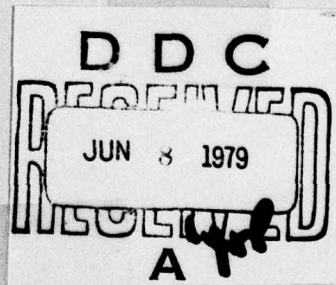
FOREIGN TECHNOLOGY DIVISION



EXTRUSION OF BIMETALLIC ADAPTERS MADE FROM STAINLESS
STEEL WITH AN ALUMINUM ALLOY

By

L. A. Nikol'skiy and V. M. Kirasirov



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EDITED TRANSLATION

FTD-ID(RS)T-0031-79

1 February 1979

MICROFICHE NR: *AD-79-C-000204*

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English pages: 7

Source: Kuznechno-Shtampovochnoye Proizvodstvo,
Nr. 11, 1972, pp. 7-9

Country of Origin: USSR

Translated by: Charles T. Ostertag, Jr.

Requester: FTD/TQTA

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U. S. BOARD ON GEOGRAPHIC NAMES TRANSLITERATION SYSTEM

Block	Italic	Transliteration	Block	Italic	Transliteration
А а	<i>А а</i>	A, a	Р р	<i>Р р</i>	R, r
Б б	<i>Б б</i>	B, b	С с	<i>С с</i>	S, s
В в	<i>В в</i>	V, v	Т т	<i>Т т</i>	T, t
Г г	<i>Г г</i>	G, g	У у	<i>У у</i>	U, u
Д д	<i>Д д</i>	D, d	Ф ф	<i>Ф ф</i>	F, f
Е е	<i>Е е</i>	Ye, ye; E, e*	Х х	<i>Х х</i>	Kh, kh
Ж ж	<i>Ж ж</i>	Zh, zh	Ц ц	<i>Ц ц</i>	Ts, ts
З з	<i>З з</i>	Z, z	Ч ч	<i>Ч ч</i>	Ch, ch
И и	<i>И и</i>	I, i	Ш ш	<i>Ш ш</i>	Sh, sh
Й й	<i>Й й</i>	Y, y	Щ щ	<i>Щ щ</i>	Shch, shch
К к	<i>К к</i>	K, k	Ъ ъ	<i>Ъ ъ</i>	"
Л л	<i>Л л</i>	L, l	Ы ы	<i>Ы ы</i>	Y, y
М м	<i>М м</i>	M, m	Ь ь	<i>Ь ь</i>	'
Н н	<i>Н н</i>	N, n	Э э	<i>Э э</i>	E, e
О о	<i>О о</i>	O, o	Ю ю	<i>Ю ю</i>	Yu, yu
П п	<i>П п</i>	P, p	Я я	<i>Я я</i>	Ya, ya

*ye initially, after vowels, and after ъ, ь; e elsewhere.
When written as ё in Russian, transliterate as yě or ě.

RUSSIAN AND ENGLISH TRIGONOMETRIC FUNCTIONS

Russian	English	Russian	English	Russian	English
sin	sin	sh	sinh	arc sh	sinh ⁻¹
cos	cos	ch	cosh	arc ch	cosh ⁻¹
tg	tan	th	tanh	arc th	tanh ⁻¹
ctg	cot	cth	coth	arc cth	coth ⁻¹
sec	sec	sch	sech	arc sch	sech ⁻¹
cosec	csc	csch	csch	arc csch	csch ⁻¹

Russian English

rot curl
lg log

FIRST LINE OF TEXT

EXTRUSION OF BIMETALLIC ADAPTERS MADE FROM STAINLESS STEEL WITH AN
ALUMINUM ALLOY

L. A. Nikol'skiy and V. M. Kirasirov

Tubular adapters made out of various metals are used for the development of permanent connections by means of welding them with the ends of pipelines made of the corresponding metals. Based on operating conditions the adapters should possess high strength, minimum weight, and impermeability under pressure in aggressive media for a long period of time.

Several methods are known for obtaining a permanent connection from different metals: drawing of nozzles from rolled bimetallic sheets, friction welding, wedge-pressure welding, explosive welding, etc.

Extensive use is made of the method of obtaining adapters by the multioperational drawing of a cylindrical billet, which subsequently is subjected to mechanical working with the removal of a considerable amount of material. After working the billet has a tapering form. Shortcomings of this method include the impossibility of obtaining adapters of great length, a low (less than 0.1) utilization factor of the metal, and a great deal of labor in the fabrication of the adapters.

Wedge-pressure welding is realized by the introduction under pressure of dynamic or static loads of a conical billet made out of a harder metal into a solid billet or thick-walled bushing made

out of softer [metal]. By this method connections of stainless steel with pure aluminum or low-alloy aluminum alloys of the AMg3 type are obtained. The shortcomings of this method include the low metal utilization factor and impossibility of applying a layer of a third metal (AD1 for example) for improving coalescence of metals which join together poorly (for example, AMg6 alloy and Kh18N10T steel).

The fabrication of adapters by explosive welding is realized in layouts with extension or compression. The obtaining of billets of adapters in one operation is very promising. However, the use of this method is connected with the creation of a special sector, and the adapter, just as in the case of drawing, has a tapering form.

A new method has been developed for obtaining bimetallic adapters.* This method is realized with the joint plastic deformation of hollow bushings made out of different metals in a heated state using the arrangement of direct extrusion (Figure 1).

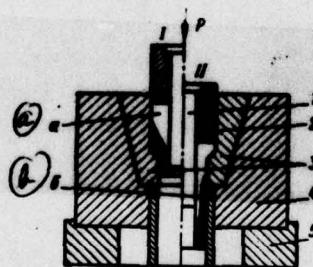


Figure 1. Layout for direct extrusion of different metals for the obtaining of a billet of a bimetallic adapter.

I - beginning of extrusion; II - end of extrusion; a - bushing made out of different metals; b - billet of bimetallic adapter; 1 - mandrel; 2 - annular ram; 3 - detachable inserts; 4 - die housing; 5 - support ring.

* Author's certificate No 300276. Bulletin "Inventions, industrial models and trade signs," 1971, No 13.

The tubular bushings being connected are set in the cavity of the detachable inserts in such a way that the softer metal (AMg6) is preceded by the harder (Kh18N10T). The die with the set of billets is heated up to the initial extrusion temperature.

By means of the annular ram the metal is pressed through the opening, formed by the cylindrical surface of the inserts and the movable mandrel which is inserted inside of the billets. With the pressing of the metal in the area of deformation high compressing stresses develop, as a result of which with the simultaneous joint deformation of the contact surfaces of the different metals their coalescence takes place.

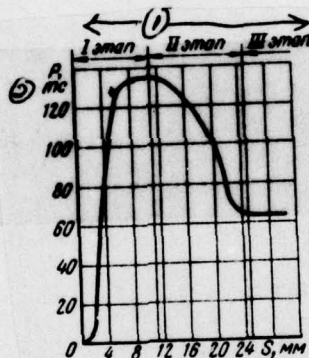


Figure 2. Diagram of the change in the force of hot extrusion from the movement of the ram.

I - pressing of the steel part of the bushing; II - combined pressing of the steel and aluminum parts; III - pressing of the aluminum part of the bushing.

Key: (1) Stage I, II, III; (2) tf.

Extrusion is realized in three stages: in the first stage the steel part of the billet is pressed, in the second - the combined pressing of the steel and aluminum parts, and in the third - pressing only of the aluminum part of the billet. Figure 2 shows the dependence of the force of extrusion on the movement of the ram. For lowering the force of extrusion and stress in the

die the deformable part of the steel billet should be made as small as possible.

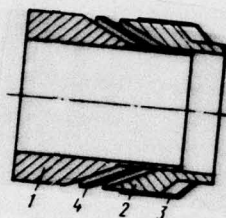


Figure 3. Initial billets for extrusion:
1 - tubular bushing with a tapering form made out of AMg6 alloy;
2 - tubular bushing with a tapering form made out of Kh18N10T steel; 3 - nozzle with conical collar made out of AD-1 aluminum foil; 4 - cone made out of AD-1 aluminum foil.

The following are the initial billets for extrusion (Fig.3):

1. Tubular bushing of tapering form made out of AMg6 alloy. The thin-walled part serves as a technological "hood," protecting the zone of connection (conical surface) from the lubricant which is applied to the tool (arbor). The "hood" also makes it possible to lower the force of extrusion, since during pressing a homogeneous soft metal is in contact with the arbor.
2. A tubular bushing of tapering form made out of Kh18N10T steel, made in the form of a cylindrical part with a conical bulge, taking part in the extrusion. The length of the cylindrical part is assigned by plan and is not deformed. The outer conical surface of the thickened part corresponds to the collar of the detachable inserts, the inner connectable conical surface corresponds to the aluminum bushing. The angle formed by the inner conical surface and the shaft has an influence on the expansion of the bimetallic part and the strength of the connection.
3. Nozzle with a conical collar made out of commercial-grade aluminum, slipped on from below on the steel bushing for reducing friction and uniform deformation during pressing.
4. Cone made out of aluminum foil brand AD1 with a thickness of 0.2-0.3 mm, which serves as an interlayer between the AMg6

alloy and the Kh18N10T steel for improving strength, plasticity and the hermetic seal of the connection.

The presence of magnesium in the aluminum alloys worsens the conditions of their welding with austenitic steel, and with a content of around 6% Mg (AMg6) it is practically impossible to obtain a strong connection, since a brittle intermetallic compound (of the FeAl_3 type) is formed. Therefore for obtaining a strong coalescence between different metals, characterized by a great difference in coefficients of linear expansion, it is recommended to use an intermediate layer made out of a third plastic metal [2].

This method of connecting different metals involves, as is evident from Figure 1, the joint deformation of billets in such a way that the billet of the harder metal traverses the zone of deformation first. The contact surface obtained in this case has the form of an irregular truncated cone from the outer surface of the tubular adapter to the inner. An increase in the area of the welded surfaces in the process of extrusion is an important factor, contributing to the destruction of oxide films and the development of juvenile surfaces, which determines the strength and hermetic seal of the connection. The strength of the connection is influenced by the high degree of deformation (extent of compression); high stress in the area of deformation, which is the result of the specific sequence of occurrence of the extrusion process (the harder metal should be deformed first and create a head), and the conical form of the contacting surfaces of the bushings.

The bimetallic adapters are fabricated in the following technological arrangement. The initial aluminum bushing and cone are subjected to etching, the steel bushing - to degreasing. Before setting in the die the bushings (primarily the connecting conical surfaces) are washed thoroughly with commercial alcohol. The set of bushings, assembled together with the cone and the outer nozzle, are placed in the cavity of detachable inserts. In the die the bushings are compressed in a cold state with a force which is approximately equal to the force of extrusion. This is achieved by the more complete isolation of the contact zone from the outer medium and prevents the oxidation of the contact surfaces of the

bushings and the penetration of vapors from the lubricant to it during heating. The die with the bushings is heated up to $390-410^{\circ}\text{C}$, after which the bushings are pressed through the annular opening of the die; a tubular bimetallic adapter is obtained.

Preliminarily the quality of connection of an adapter which has been worked by sharpening can be judged by its sound when it is struck. A ringing tone testifies to the absence of breaks in the connection, a dull sound - is the sign of separation into layers on a certain section of the contact surface.

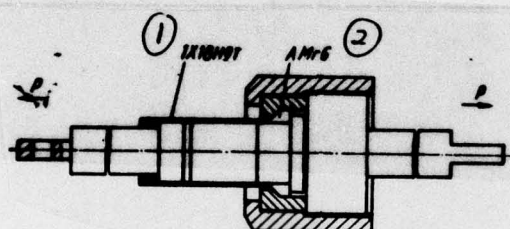


Figure 4. Device for tensile testing of turned bimetallic adapters.
Key: (1) 1Kh18N9T; (2) AMg6.

The quality of the connection is determined as a result of the conducting of mechanical tensile tests on turned adapters (wall thickness $s=1.5-2$ mm) with the help of a special device (Figure 4). Using interchangeable parts, it is possible to test several size-types of adapters. Destruction of adapters which were fabricated by extrusion took place on the main metal - the aluminum alloy AMg6. Tensile strength comprised $28-32 \text{ kgf/mm}^2$ (Figure 5).

The adapters were also subjected to control tests according to the plant program and stood up successfully to a check for hydraulic load, pressurization and hermetic seal.

In the case of testing with pressure up to destruction an adapter with $D_{BH}=40$ mm broke down with $p=360 \text{ kgf/cm}^2$, an adapter with $D_{BH}=60$ mm - with $p=170 \text{ kgf/cm}^2$. The site of breakdown - all the zones of connection (Figure 6). Operating pressure of the

liquid in the adapter comprises 30 kgf/cm^2 , control pressure during pressurizing 45 kgf/cm^2 .

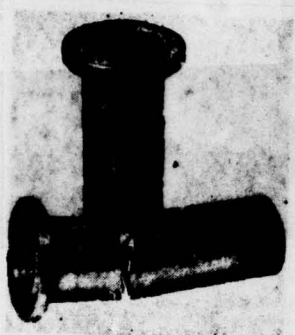


Figure 5. Nature of breakdown of bimetallic adapters during tensile testing.



Figure 6. Nature of breakdown of bimetallic adapters during hydraulic loading.

The developed method of fabrication of bimetallic adapters ensures higher indices of strength and hermetic sealing, a considerable lowering of cost of production (by 3-4 times in comparison with those produced from rolled bimetallic sheets), and also mobility of production. With this method it is possible to obtain adapters from standard billets (tubes, bars) on universal equipment (hydraulic presses).

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